Periodic Table

Categorizations of Elements

- Metalloids: boron (B), silicon (S), arsenic (As), germanium (Ge), antimony (Sb), tellurium (Te), and polonium (Po)
- Metals: everything to the left of the metalloids
- Nonmetals: everything that is not a metal
- Noble or inert gases: column on the right
- Halogens: column next to noble gases

Chemistry 6-2a

Oxidation State

Oxidation number (oxidation state)

- An electrical charge assigned by a set of prescribed rules.

Elements have valence shells

- Noble gases: completely filled shells (stable)
- Non-noble elements: achieve a more stable shell by adding/losing electrons

For example, carbon (C) can gain four electrons (–4 valence), or lose four (+4 valence) to reach the neon (Ne) valence state—or it can lose two (+2 valence) to reach the beryllium (Be) valence state.

Nitrogen (N) the most notable exception, can have any valence in its row (+5 to –3, but never zero).

Some valence states to remember are:

- hydrogen (H) column: +1
- beryllium (Be) column: +2
- boron (B) column: +3
- fluorine (F): –1
- oxygen (O): –2
- carbon (C): can be +2, +4, or –4

Oxidation State

Example 1 (EIT8):

Example 29.5

What are the oxidation numbers of all the elements in the chlorate (ClO_3^{-1}) and permanganate (MnO_4^{-1}) ions?

(solution)

For the chlorate ion, the oxygen is more electronegative than the chlorine. Therefore, the oxidation number of oxygen is −2. In order for the net oxidation number to be −1, the chlorine must have an oxidation number of +5.

For the permanganate ion, the oxygen is more electronegative than the manganese. Therefore, the oxidation number of oxygen is −2. For the net oxidation number to be −1, the manganese must have an oxidation number of +7.

Oxidation State

Example 2 (FEIM):

The valence (oxidation state) of manganese in potassium permanganate, $KMnO_4$ is:

(A) +7
(B) +5
(C) +4
(D) +3

Oxygen has only a –2 oxidation state, and K has an oxidation state of +1. Since there is no charge on the molecule, the Mn must have an oxidation state of +7.

Therefore, (A) is correct.

Inorganic Chemistry

Chemical Names

There are only ten elements where the symbol does not start with the element's first letter; these are:

Antimony	=	Sb
Gold	=	Au
Iron	=	Fe
Lead	=	Pb
Mercury	=	Hg
Potassium	=	K
Silver	=	Ag
Sodium	=	Na
Tin	=	Sn
Tungsten	=	W

Inorganic Chemistry

Definitions

- atomic number
- carbon 12
- atomic weight
- isotope

Inorganic Chemistry: Moles

Mole

- 1 mol of carbon 12 = 12 g
- number of atoms/molecules in a mole = 6.02×10^{23} (Avogadro's number)
- 1 mol of any gas at STP occupies 22.4 L

Example 1 (FEIM):

How many electrons are in 0.01 g of gold?

The atomic weight of gold is 196.97 g/mol, so 0.01 g of gold is 5.077×10^{-5} mol.

$$\left(5.077 \times 10^{-5}\ \text{mol}\right)\left(6.02 \times 10^{23}\ \frac{\text{atom}}{\text{mol}}\right) = 3.057 \times 10^{19}\ \text{atoms}$$

$$\left(3.057 \times 10^{19}\ \text{mol}\right)\left(79\,\frac{\text{electrons}}{\text{atom}}\right) = 2.42 \times 10^{21}\ \text{electrons}$$

Inorganic Chemistry: Moles

Example 2 (FEIM):

Which of the following is NOT approximately equal to a mole?

(A) 22.4 L of nitrogen (N_2) gas at STP

(B) 6.02×10^{23} O_2 molecules

(C) 16 g of O_2

(D) 2 g of H_2

Oxygen has an atomic weight of 16 g/mol. However, it is diatomic, meaning there are two oxygen atoms in every oxygen molecule. So it would take 32 g of O_2 to make a mole.

Therefore, the answer is (C).

Inorganic Chemistry: Moles

Definitions

- gram-mole
- mole fraction

Example (FEIM):
Atomic weights are taken as 75 g for arsenic, 16 g for oxygen, and 12 g for carbon. According to the equation $As_2O_3 + 3C \rightarrow 3CO + 2As$, the reaction of 1 gmol of As_2O_3 with carbon will result in the formation of:

(A) 1 gmol of CO
(B) 1 gmol of As
(C) 28 g of CO
(D) 150 g of As

Each gram-mole of As_2O_3 will result in 2 gmol of As. Because each gram-mole of As weighs 75 g, then 2 gmol of As weighs 150 g.

Therefore, (D) is correct.

Inorganic Chemistry: Equivalent Weight

Equivalent weight is the molecular/atomic weight divided by the electrons exchanged in a chemical or electro chemical reaction.

Example (EIT8):

Example 29.3

What are the equivalent weights of the following compounds?

(a) Al in the reaction

$$Al^{+++} + 3e^- \longrightarrow Al$$

(b) H_2SO_4 in the reaction

$$H_2SO_4 + H_2O \longrightarrow 2H^+ + SO_4^{--} + H_2O$$

(c) NaOH in the reaction

$$NaOH + H_2O \longrightarrow Na^+ + OH^- + H_2O$$

(solution)

(a) The atomic weight of aluminum is approximately 27. Since the change in the oxidation number is 3, the equivalent weight is $27/3 = 9$.

(b) The molecular weight of sulfuric acid is approximately 98. Since the acid changes from a neutral molecule to ions with two charges each, the equivalent weight is $98/2 = 49$.

(c) Sodium hydroxide has a molecular weight of approximately 40. The originally neutral molecule goes to a singly-charged state. Therefore, the equivalent weight is $40/1 = 40$.

Inorganic Chemistry: Reactions/Equations

Example 1 (FEIM):

Balance the equation $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$.

(left) 1 Al → 2 Al (right), so multiply the Al on the left by 2.
(left) 1 SO_4 → 3 SO_4 (right), so multiply the H_2SO_4 on the left by 3.
As a result, there are now 3 H_2 on the left, so multiply the H_2 on the right by 3.

$$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$$

Example 2 (FEIM):

What is the smallest possible whole-number coefficient for Na_2CO_3 when the following reaction is balanced?

$$Na_2CO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

There are 2 H on the right, so multiply the HCl on the left by 2.
Now, there are 2 Cl on the left, so multiply the NaCl on the right by 2.
Now the equation balances, and the coefficient of Na_2CO_3 is 1.
The complete equation is:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

Inorganic Chemistry: Reactions/Equations

Example 3 (FEIM):

Balance the reaction $FeS_2 + O_2 \rightarrow Fe_2O_3 + SO_2$.

(left) 1 Fe → 2 Fe (right), so multiply FeS_2 by 2.

Now, (left) 4 S → 1 S (right), so multiply SO_2 by 4.

So far, we have: $2FeS_2 + O_2 \rightarrow Fe_2O_3 + 4SO_2$

(left) 2 O → 11 O (right), so multiply the O_2 on the left by 11 and the others on the right by 2. But now there are 2 Fe on the left and 4 Fe on the right, so a final multiplication balances the equation.

$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

Inorganic Chemistry: Oxidation-Reduction Reactions

Oxidation
An element of molecule loses electron(s).

Reduction
An element of molecule gains electron(s).

Example:

For the following reaction, what is oxidized? What is reduced? What is the oxidizing agent? What is the reducing agent?

$$2HNO_3 + 3H_2S \rightarrow 2NO + 4H_2O + 3S$$

The S has an oxidation state of –2 on the left and 0 on the right, so it was oxidized. The N has an oxidation state of +5 on the left and +2 on the right, so it was reduced. The oxidizing agent is what is reduced. The HNO_3 releases an NO_3^- ion that is reduced, so this is the oxidizing agent. The reducing agent, which is what is oxidized, is the H_2S.

Inorganic Chemistry: Oxidation-Reduction Reactions

To balance O-R reactions:

1. Write the unbalanced equation.
2. Assign oxidation numbers to all elements.
3. Find the elements that change oxidation state.
4. Balance so there is the same number of electrons on both sides for oxidized and reduced elements.
5. Balance the remainder of the equation as a simple reaction.

Example:

How many $AgNO_3$ molecules are formed per NO molecule in the reaction of silver with nitric acid?

1. The unbalanced reaction is $Ag + HNO_3 \rightarrow AgNO_3 + NO + H_2O$.
2. The oxidation number of Ag in $AgNO_3$ is +1 because 3 O has an oxidation number of -6 and N can have a maximum oxidation number of +5. The N in HNO_3 has an oxidation number of +5 (same as above). The N in NO has an oxidation number of +2.
3. Therefore, each Ag is oxidized by losing 1 e^-, and each N in each NO is reduced by gaining 3 e^-.
4. So there must be 3 $AgNO_3$ created for every NO created.

Inorganic Chemistry: Stoichiometry

Stoichiometry

The mass of the reactants is used to find the mass of the products or vice versa.

1. Balance the equation.
2. Find atomic or molecular weights of everything in the equation.
3. Combining weights are proportional to the product of the molecular weights and the coefficients.

Example 29.10

Caustic soda (NaOH) is made from sodium carbonate (Na_2CO_3) and slaked lime ($Ca(OH)_2$) according to the given reaction. How many kilograms of caustic soda can be made from 2000 kg of sodium carbonate?

(solution)

	Na_2CO_3	$+\ Ca(OH)_2$	$\longrightarrow 2NaOH$	$+\ CaCO_3$
molecular weights	106	74	2×40	100
given data	2000 kg		X kg	

The simple ratio used is

$$\frac{NaOH}{Na_2CO_3} = \frac{80}{106} = \frac{X}{2000}$$

Solving for the unknown mass, $X = 1509$ kg.

Solutions

Gases in Liquids

- Gases can dissolve in liquids.

Solids in Liquids

- Solids can dissolve in liquids.

Example (FEIM):

1 L of water will absorb 0.043 g of O_2 when in contact with pure O_2 at 20°C and 1 atm, or 0.19 g of N_2 when in contact with pure N_2 at 20°C and 1 atm. Air contains 20.9% O_2 by volume, and the rest is N_2. What masses of O_2 and N_2 will be absorbed by 1 L of water in contact with air at 20°C at 1 atm?

$$m_{O_2} = (0.209)\left(0.043\ \frac{\text{g}}{\text{L}}\right) = 0.009\ \text{g/L}$$

$$m_{N_2} = (1 - 0.209)\left(0.19\ \frac{\text{g}}{\text{L}}\right) = 0.150\ \text{g/L}$$

Solutions

Unit of concentration:

- Molarity – number of gmol/L of solution
- Molality – number of gmol/1000 g of solution
- Normality – number of gram-equivalent weight/L of solution
- Normal solution – gram-equivalent weight/L of solution

Example (EIT8):

Example 29.12

A solution is made by dissolving 0.353 grams of $Al_2(SO_4)_3$ in 730 grams of water. Assuming 100% ionization, what is the concentration expressed as normality, molarity, and mg/l?

(solution)

The molecular weight of $Al_2(SO_4)_3$ is

$$\text{MW} = (2)(26.98) + 3[32.06 + (4)(16)] = 342.14$$

The equivalent weight is $342.14/6 = 57.02$

The number of gram equivalent weights used is

$$0.353/57.02 = 6.19 \times 10^{-3}$$

The number of liters of solution (same as the solvent volume if the small amount of solute is neglected) is 0.73.

The normality is

$$N = \frac{6.19 \times 10^{-3}}{0.73} = 8.48 \times 10^{-3}$$

The number of moles of solute used is $0.353/342.14 = 1.03 \times 10^{-3}$.

The molarity is

$$M = \frac{1.03 \times 10^{-3}}{0.73} = 1.41 \times 10^{-3}$$

The number of milligrams is $0.353/0.001 = 353$.

$$\text{mg/l} = \frac{353}{0.73} = 483.6$$

Solutions

Boiling and Freezing Points

- Boiling-Point Elevation:

$$\Delta T_b = mK_b = \frac{m_{\text{solute,in g}} K_b}{(\text{MW}) m_{\text{solvent,in kg}}} \quad \text{[increase]} \qquad 39.3$$

- Freezing-Point Depression:

$$\Delta T_f = -mK_f = \frac{-m_{\text{solute,in g}} K_f}{(\text{MW}) m_{\text{solvent,in kg}}} \quad \text{[decrease]} \qquad 39.4$$

Example (EIT8):

Example 29.13

4.2 g of a non-ionizing solute was dissolved in 112 g of acetone (K_b = 1.71°C/m, T_b = 55.95°C). The boiling point of the solution increased to 56.7°C. What is the approximate molecular weight of the solute?

(solution)

From Eq. 29.16,

$$\begin{aligned} \text{MW} &= \frac{m_{\text{solute, in g}} \times K_b}{m_{\text{solvent, in kg}} \times \Delta T_b} \\ &= \frac{(4.2 \text{ g})(1.71°\text{C})}{(0.112 \text{ kg})(56.7°\text{C} - 55.95°\text{C})} \\ &= 85.5 \text{ g/mol} \end{aligned}$$

NOTE: Pay attention to units.

Inorganic Chemistry: Solutions

Acids

- Molecules that release H^+ ions in water
- pH < 7

Bases

- Molecules that release OH^- ions in water
- pH > 7

$$\text{pH} = -\log_{10}[\text{H}^+] = \log_{10}\left(\frac{1}{[\text{H}+]}\right) \qquad 38.11$$

$[H^+]$ and $[OH^-]$ are H^+ and OH^- concentration, respectively.

pH = 7 defines a neutral solution

pH + pOH = 14

Inorganic Chemistry: Solutions

Example (FEIM):

A 0.1 normal solution of hydrochloric acid has a pH of 1.1. What is the percent ionization?

$$pH = -\log_{10}\left[H^+\right] = 1.1$$

$$\log_{10}\left[H^+\right] = -1.1$$

Take the inverse logarithm of both sides.

$$\left[H^+\right] = 10^{-1.1} = 0.079 \text{ mol/L}$$

$$\left[H^+\right] = (\text{fraction ionized})(\text{molarity})$$

Since HCl releases only 1 H^+ ion per molecule, the normality and molarity are the same.

$$\text{fraction ionized} = \frac{\left[H^+\right]}{\text{molarity}} = \frac{\left(0.079\ \frac{\text{mol}}{\text{L}}\right)}{\left(0.1\frac{\text{mol}}{\text{L}}\right)} = 0.79$$

$$\text{percent ionized} = (\text{fraction ionized})100\% = 79\%$$

Inorganic Chemistry: Solutions

Neutralization

When acids and bases combine, they lose H^+ and OH^- to make H_2O, and the other ions form salts.

Example (FEIM):

The atomic weight of sodium is 23, of oxygen is 16, and of hydrogen is 1. To neutralize 4 grams of NaOH dissolved in 1 L of water requires 1 L of

(A) 0.001 N HCl solution
(B) 0.01 N HCl solution
(C) 0.1 N HCl solution
(D) 1.0 N HCl solution

The molecular weight of NaOH is approximately 40, which is equal to the equivalent weight (1 e^- exchanged).
Since we had 4 g of solute, the gram equivalent weight is 4/40 = 0.1.
Normality is the gram equivalent weight per L, and since we have 1 L, the normality is 0.1/1 = 0.1.
Since the HCl is also 1 L, its normality must be the same.
Therefore, (C) is correct.

Inorganic Chemistry: Solutions

Equilibrium

- Solutions can have both reactants and products existing together.
- Equilibrium is when the concentration of reactants and products is not changing.

Inorganic Chemistry: Solutions

Le Châtelier's Principle:

- A reversible reaction requires energy to go one direction and releases energy when going the other direction.
- When a reaction at equilibrium is stressed, it reacts to relieve that stress.

Inorganic Chemistry: Solutions

Equilibrium Constant:

For $aA + bB \rightleftharpoons cC + dD$ *38.2*

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b} = \frac{k_{forward}}{k_{reverse}} \quad 38.5$$

Solubility Constant:

For $A_mB_n \Leftrightarrow mA^+ + nB^-, K_{sp} = \left[A^+\right]^m \times \left[M^-\right]^n$

Example (FEIM):

At a particular temperature, it takes 0.038 g of $PbSO_4$, with a molecular weight of 303.25 g/mol, per liter of water to prepare a saturated solution. What is the solubility product of $PbSO_4$ if all of it ionizes?

$$\left[Pb^{+2}\right] = \left[SO_4^{-2}\right] = \frac{\left(\dfrac{0.038 \text{ g}}{303.25 \dfrac{\text{g}}{\text{mol}}}\right)}{1\text{L}} = 1.25 \times 10^{-4} \ \frac{\text{mol}}{\text{L}}$$

$$K_{sp} = (1.25 \times 10^{-4})(1.25 \times 10^{-4}) = 1.56 \times 10^{-8}$$

Inorganic Chemistry: Solutions

Ideal Gas Law:

$$\rho = \frac{1}{\nu} = \frac{p}{RT} \qquad 38.8$$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} \qquad 38.9$$

$$pV = n\overline{R}T \qquad 38.10$$

Molar Volume – volume of one mole of ideal gas (22.4 L at STP for any gas)

Example (FEIM):

Ethane gas burns according to the equation $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$. What volume of CO_2, measured at standard temperature and pressure, is formed for each gram-mole of C_2H_6 burned? Assume an ideal gas.

(A) 22.4 L
(B) 44.8 L
(C) 88.0 L
(D) 89.6 L

Inorganic Chemistry: Solutions

$$V = \frac{nRT}{P} = \frac{(2\ \text{mol})\left(8314\ \frac{\text{J}}{\text{kmol}\cdot\text{K}}\right)\left(\frac{1\ \text{kmol}}{1000\ \text{mol}}\right)(273.16\text{K})}{(1\ \text{atm})\left(\frac{1.013\times 10^{5}\ \text{Pa}}{1\ \text{atm}}\right)\left(\frac{\text{m}^{3}}{1000\ \text{L}}\right)}$$

$$= 44.8\ \text{L}$$

Therefore, B is correct.

Inorganic Chemistry: Solutions

Kinetics

Reversible reaction rates depend on:

- substances in reaction
- exposed surface
- concentrations
- temperature
- catalysts

Electrochemistry

Electrochemical reactions are reactions forced to proceed by supplying electrical energy.

- Cathode is negative
- Anode is positive

Electrochemistry

Faraday's Laws

1. The mass of a substance created by electrolysis is proportional to the amount of electricity used.
2. For any constant amount of charge used, the mass of substance created is proportional to its equivalent weight.
3. One faraday (96,487 C) is the charge of one mole of electrons and will produce one gram of equivalent weight.

$$m_{\text{grams}} = \frac{It(\text{MW})}{(96\,485)(\text{change in oxidation state})} = (\text{no. of faradays})(\text{GEW}) \qquad 39.5$$

Electrochemistry

Example 1 (EIT8):

Example 29.21

What current is required to produce two grams of metallic copper (atomic weight = 63.6) from a copper sulfate solution in 1.5 hours?

(solution)

The electrolysis reaction is

$$Cu^{+2} + 2e^- \longrightarrow Cu$$

Since the change in charge on the copper is 2, the equivalent weight of copper is

$$EW_{Cu} = \frac{63.6}{2} = 31.8$$

[32]An electron has 1.602×10^{-19} C of charge. A *faraday* is the charge associated with one mole of electrons. Therefore, a faraday is

$$\begin{aligned} \text{faraday} &= \left(1.6022 \times 10^{-19} \, \frac{\text{C}}{\text{electron}}\right)(6.022 \times 10^{23} \text{ electrons}) \\ &= 96{,}485 \text{ C} \end{aligned}$$

From Eq. 29.42,

$$\begin{aligned} m_{\text{grams}} &= \frac{It \times (\text{MW})}{(96{,}485)(\text{change in oxidation state})} \\ 2 \text{ g} &= \frac{I(1.5 \text{ h})\left(3600 \, \frac{\text{s}}{\text{h}}\right)\left(31.8 \, \frac{\text{g}}{\text{EW}}\right)}{96{,}485 \, \frac{\text{A}\cdot\text{s}}{\text{EW}}} \\ I &= 1.12 \text{ A} \end{aligned}$$

Electrochemistry

Example 2 (FEIM):

In electrolysis, the anions migrate to the anode. Which of the following ions migrate to the other electrode?

(A) acidic ions
(B) cations
(C) neutral ions
(D) zwitterions

The “other electrode” is the cathode, which is negatively charged. The cation is a positive ion, so it will migrate to the cathode.

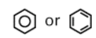
Therefore, (B) is correct.

Organic Chemistry

- Organic – any molecule that has one or more carbon atom(s).
- Shape of an orbital: tetrahedron
- The carbon atom shares electrons with four other atoms in the –4 valence state along the points of the tetrahedron.

Organic Chemistry

Functional Groups

alkane C-H and C-C		alkene C = C	alkyne C ≡ C	arene aromatic ring 	alcohol hydroxyl C-OH
ether C-O-C	amine amino C-N	aldehyde $-\overset{O}{\overset{\|}{C}}-H$	carboxylic acid $CH_3\overset{O}{\overset{\|}{C}}OH$	ester $-\overset{O}{\overset{\|}{C}}-O-C$	ketone carbonyl (keto) $-C-\overset{O}{\overset{\|}{C}}-C-$

Example (FEIM):

The combination of an alkyl radical with a hydroxyl groups forms

(A) an alcohol
(B) an acid
(C) an aldehyde
(D) a carboxyl

This problem can be represented as the chemical formula

$$C_nH_{2n}^+ + OH^- \rightarrow C_nH_{2n}OH$$

The product is an alcohol. Therefore, (A) is correct.

Organic Chemistry

Families of Organic Compounds

- Organic compounds that have the same functional group belong to the same family.

Example 1 (FEIM):

Which compound families are associated with the following bonds?

1. C - C 2. C = C 3. C ≡ C

(A) 1: alkene, 2: alkyne, 3: alkane
(B) 1: alkyne, 2: alkane, 3: alkene
(C) 1: alkane, 2: alkene, 3: alkyne
(D) 1: alkane, 2: alkyne, 3: alkene

Looking at the table for the compound families, we see that

1. C - C is an alkane
2. C = C is an alkene
3. C ≡ C is an alkyne

Therefore, (C) is correct.

Organic Chemistry

Example 2 (FEIM):
Which of the following organic chemicals is most soluble in water?

(A) CH_3CH_3
(B) CH_3OH
(C) CCl_4
(D) $CH_3\text{-}(CH_2)_n\text{-}CH_3$

All the possible answers are symmetric molecules except for CH_3OH, which has the hydroxyl group (OH). CH_3OH is a polar molecule and water is a polar molecule. Polar molecules (e.g., alcohols) are highly soluble in polar solvents (e.g., water).

Therefore, (B) is correct.

Half-Life

- Radioactive elements decay exponentially.
- $t_{1/2}$ is the time required for half of the original atoms to decay.

$$N = N_0 e^{-0.693t/t_{1/2}} \qquad 37.4$$

Example (EIT8):

Example 61.3

What will be the activity of 60 kg of Pu-239 (half-life of 24,100 years) after 2000 years?

(solution)

From Eq. 61.14, the decay constant is

$$\lambda = \frac{0.6931}{t_{1/2}} = \frac{0.6931}{24{,}100a} = 2.876 \times 10^{-5} a^{-1}$$

The mass, number of moles, and number of atoms of Pu-239 after 2000 years will be

$$m_{2000} = m_0 e^{-\lambda t} = (60 \text{ kg}) e^{-(2.88 \times 10^{-5} \frac{1}{a})(2000a)} = (60 \text{ kg})(0.9440) = 56.64 \text{ kg}$$

$$n_{2000} = \frac{m}{A} = \frac{56.64 \text{ kg}}{239 \frac{\text{kg}}{\text{kmol}}} = 0.2370 \text{ kmol}$$

$$N_{2000} = n \times N_A = (0.2370 \text{ kmol}) \left(1000 \frac{\text{mol}}{\text{kmol}}\right) \times \left(6.023 \times 10^{23} \frac{\text{atoms}}{\text{mol}}\right) = 1.427 \times 10^{26} \text{ atoms}$$

From Eq. 61.17, the activity after 2000 years will be

$$A_{2000} = \lambda N_{2000} = \frac{\left(2.876 \times 10^{-5} \frac{1}{a}\right)(1.427 \times 10^{26} \text{ atoms})}{\left(365 \frac{d}{a}\right)\left(24 \frac{h}{d}\right)\left(3600 \frac{s}{h}\right)} = 1.302 \times 10^{14} \text{ Bq}$$